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Capital Markets Study

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**Discrimination in Capital Markets, Broadcast/Wireless Spectrum
Service Providers and Auction Outcomes**

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Executive Summary

The objective of this study is to assist the Federal Communications Commission (“FCC”) in implementing Sections 257 and 309(j) of the Telecommunications Act of 1996, as amended. Section 257 requires the FCC to identify and eliminate market entry barriers for small telecommunications businesses. Section 309(j) requires the FCC to further opportunities in the auctioning of spectrum-based services for small businesses and businesses owned by women and minorities.

This study is comprised of two parts. The first part examines whether capital market discrimination may be a market entry barrier for firms seeking to acquire FCC licenses. Specifically, it explores whether and to what extent applicants for FCC licenses may have suffered discrimination in capital markets. The second part of this study compares the success rates of firms owned by minorities, women and non-minorities in auctions for FCC wireless licenses. Specifically, it examines whether, when controlling for relevant variables, race or gender is a statistically significant variable in predicting success in FCC auctions.

The first part of this study stems from a recognition that a lack of adequate capital is a critical barrier to entering business, business growth, and success in auctions for broadcast/wireless spectrum service providers. This study investigates the extent to which the capital markets discriminate against women and minority-owned broadcast/wireless firms in providing debt capital. Discrimination in capital markets is indicated when controlling for relevant variables, race or gender is a statistically significant variable in predicting an applicant’s success in capital markets. Prior studies

(reviewed in this report) have not been industry specific, but they lead to the hypothesis that minority broadcast license holders or minorities attempting to acquire broadcast licenses experience capital market discrimination.

The second part of this study analyzes the differences in the ability to acquire a wireless license between businesses owned by minorities and women, and other businesses. It tests the hypothesis that minority/women applicants in FCC Spectrum Auctions encounter discrimination in capital markets. If capital market impediments are pervasive, then they may lead minorities and women to be less successful in FCC license auctions and in purchasing FCC licenses in the secondary markets. The objective of this research is to test each of these hypotheses.

These hypotheses were tested on data from a survey of current broadcast license holders and a survey of participants in auctions for wireless licenses. For broadcasters, the survey data covers only broadcast licensees and not applicants who may have been unsuccessful.¹ The FCC contracted for the survey for the fall of 1999. For broadcasters, the survey instrument was mailed to a random sample of non-minority license holders. In addition, a census was taken of minority license holders. The survey data provide a financial portrait of the firm prior to the acquisition of its most recent license, and the year of the most recent acquisition. For the most recent acquisition, information on the number of attempts to obtain debt financing from financial institutions is contained in the data. The survey instrument also provided data on the interest paid on the debt that financed a broadcaster's most recent license acquisition. There are ninety-nine current

¹ The FCC wanted to include unsuccessful applicants, but the data on the latter were old and had many incorrect addresses. Thus it was felt that the survey of unsuccessful applicants was too incomplete to be useful. The data only covers broadcasters who obtained licenses through the comparative hearings process or on the secondary market—no broadcast auctions were included.

license holders in the data, but the statistical tests use from thirty-eight to sixty-one firms because of nonresponse for some items.

For wireless firms, financial data and other data on auction applicants are from the FCC Auction Application Survey. Auction applicants were asked to discuss their latest license acquisition or attempted acquisition. In addition, information was gathered on how the license applicants had financed the acquisition and the financial measures describing their financial condition at that time. The Auction Survey data are supplemented by data from the FCC Website. Data on both the number of qualified bidders and the number of applicants are taken from the FCC Website. The statistical tests on capital market experience of auction participants included twenty to forty-one firms because of nonresponse on some items. The auction outcome analyses contained as few as ninety-six and as many as 170 firms because some data were not available on all of the 251 respondent firms.

The findings of the study can be divided into two parts. The first part is the capital market experience of minorities and women compared to non-minorities and the second part is the auction experience of minorities and women compared to non-minorities.

Minority- and Women-Owned Firms in the Capital Markets Compared to Non-Minority Owned Firms

Broadcast Firms: The capital market experiences of current broadcast license holders were examined in regression analyses that considered, in addition to race and gender, the year of application or acquisition, business cash flow, equity, and size of firm (full-time employees). It was found that minority broadcast license holders were less likely to be accepted in their applications for debt financing, after controlling for the effect of the other variables on the lending decision. This finding was statistically

significant in the each of the three models examined in the report. It was also found that the applications for debt financing from female applicants were less likely to be approved, but this finding was not statistically significant. The impact of race on the rate of interest paid on loans was also examined in regression analyses that included the variables above, plus collateral and personal guarantees on the loan as variables. It was found that the minority borrowers paid higher interest rates on their loans, after controlling for the impact of the other variables. This finding was statistically significant. Gender was not found to be statistically significant in predicting differences in interest rates paid by borrowers.

Wireless Firms: The study also analyzes the experience of wireless applicants' access to capital, and regression analysis was used to examine the data. The models used considered variables that included the number of licenses won before the latest auction, whether or not the business was a startup, the type of auction in which the respondent participated, in addition to the financial variables listed above for broadcast applicants. It was found that loan applications of minority wireless firms were less likely to be accepted than those of nonminority firms, after controlling for the effect of the other variables on the lending decision. This finding was statistically significant in each of the three models tested. It was also found that the applications for debt financing from female applicants were less likely to be approved, and this result was also statistically significant. The impact of race on the rate of interest paid on loans was also examined in a regression analysis that considered the variables above, plus whether the applicant provided collateral and a personal guarantee on the loan. It was found that the minority borrowers paid higher interest rates on their loans, after controlling for the impact of the

other variables. Gender was not found to be statistically significant in predicting differences in interest rates paid by borrowers.

The Auction Experiences of Minority- and Women-Owned Firms Compared to Those of Non-Minority Owned Firms

With regard to the auction experience of minority- and women-owned businesses, seven regression models were developed to examine differences in success between minority-owned and women-owned auction participants and other participants. The seven models that were utilized controlled for time, auction group, startup status, size of company, financial strength, and competition. The data support the hypothesis that minority status results in a lower probability of winning in spectrum auctions. That is, for each of the seven models, the probability of a minority-owned firm winning a license in the firm's most recent auction is lower than the probability of a non-minority owned firm winning a license in its most recent auction, and the differences are statistically significant. The data also support the hypothesis that gender has a negative impact on winning spectrum auctions when we control for the variables above, but less strongly. In five of the seven models tested, female gender was statistically significant in predicting a lower probability of success in spectrum auctions. In the other two models female gender was found to reduce the probability of success, but the results were not statistically significant.

Discussion of Results and Recommendations

It is found that minority-owned firms and women-owned firms are less likely to receive debt financing in the capital markets than nonminority-owned firms. In addition, those minority firms that received loans from financial institutions pay higher interest rates than nonminority firms when we control for relevant variables. These result hold

for both wireless license applicants and broadcast licensees. Second, both minority and women-owned businesses have lower probabilities of winning wireless spectrum licenses in auctions after controlling for relevant variables.

It must be noted that the results of both the capital markets and auctions analyses are not fully conclusive due to incomplete data and in some cases small sample sizes. All of the analyses reported here explained a statistically significant part of the variation in loan acceptance, interest rates on loans, and auction outcomes. But none of the models explained all of the variation, meaning that all of the relevant variables may not be in the models that are utilized. Nevertheless, the consistent direction of the results suggest that, without a remedy for capital market discrimination, minority- and women-owned businesses are inappropriately disadvantaged in obtaining FCC broadcast and wireless licenses.

The recommendations that result from this study are as follows. First, it is recommended that the FCC develop and maintain programs that seek and encourage the participation of minorities and women in the ownership of broadcast and spectrum licenses. Such efforts may offset the disadvantages that minority- and women-owned firms experience through the capital markets. Second, it is recommended that the FCC continue to examine the effect of capital markets on the participation of minority- and women-owned firms in the ownership and operation of broadcast and spectrum licenses. Although this study indicates that minority- and women-owned firms are inappropriately disadvantaged in this line of business due to capital market forces, more research is needed to confirm and track these effects over time.

Discrimination in Capital Markets, Broadcast/Wireless Spectrum Service Providers and Auction Outcomes

Part 1. Introduction

The objective of this study is to assist the FCC in implementing Sections 257 and 309(j) of the Telecommunications Act of 1996, as amended. Section 257 requires the FCC to identify and eliminate market entry barriers for small telecommunications businesses. Section 309(j) requires the FCC to further opportunities in the auctioning of spectrum-based services for small businesses and businesses owned by women and minorities.

This study consists of two parts. The first part examines whether and to what extent applicants for FCC licenses have experienced discrimination in capital markets. The history of capital market discrimination is well documented in regulatory, legal and economic literature. Although this literature is quite comprehensive, the literature does not specifically investigate whether and to what extent, if any, capital market discrimination affects minority- and women-owned broadcast/wireless spectrum service providers. In addition, this literature does not specifically examine whether and to what extent capital market discrimination adversely affects the opportunities for minorities and women to obtain FCC spectrum licenses and to enter the broadcast and wireless markets for the first time. However, this literature does suggest the hypothesis that the inability to obtain adequate capitalization may be a critical market entry barrier for those seeking to become broadcast and wireless spectrum service providers and a critical barrier to business growth in these fields.

This study investigates the extent to which the capital markets discriminate against women and minority-owned broadcast/wireless firms in providing debt capital. Discrimination in capital markets is indicated when controlling for relevant variables, race or gender is a statistically significant variable in predicting an applicant's success in capital markets. A review of prior research in Part 2 suggests the hypothesis that minority broadcast license holders or minorities attempting to acquire broadcast licenses experience capital market discrimination. Another hypothesis is that minority/women applicants in FCC Wireless Spectrum Auctions encounter discrimination in capital markets. The objective of this research is to test these hypotheses.

The second part of this study explores the relative success in FCC auctions of firms owned by minorities, women, and non-minorities. Through logistic regression analyses, it examines whether, when controlling for relevant variables, race or gender is a statistically significant variable in predicting success in FCC wireless auctions.

Thus the findings of this study may be divided into two parts. First, with regard to capital market discrimination, the data suggest that race and gender matter in the approval/denial of loans from financial institutions and that race affects interest rates on approved loans. Specifically, after controlling for relevant variables, minority-owned firms and women-owned firms were less likely to receive debt financing in the capital markets than nonminority-owned firms. In addition, those minority firms that received loans from financial institutions paid higher interest rates than non-minority firms when we controlled for the relevant variables. These results held for both wireless license applicants and broadcast licensees. Second, we examined the probability of minorities/women-owned business winning spectrum licenses in FCC Spectrum

Auctions. The data support the hypotheses that both minority and women-owned businesses have lower probabilities of winning spectrum licenses after controlling for relevant variables.

It must be noted that the results of both the capital markets and auctions analyses are not fully conclusive due to incomplete data and in some cases small sample sizes. All of the analyses reported here explained a statistically significant part of the variation in the loan acceptance, interest rates on loans, and auction outcomes. But none of the models explained all of the variation, meaning that all of the relevant variables may not be in the models that are utilized. Nevertheless, the consistent direction of the results suggest that, without a remedy for capital market discrimination, minority and women-owned businesses are inappropriately disadvantaged in obtaining FCC broadcast and wireless licenses.

The rest of this report is organized as follows. Part 2 discusses previous studies on discrimination in capital markets relating to applications for debt financing of minority- and women-owned firms. Part 3 discusses the hypotheses, data and statistical approach to the study. Part 4 reports the analyses on experience of minority and women-owned firms in seeking debt financing in the capital markets. Part 5 discusses the results of the analyses on the experience of minority- and women-owned firms in spectrum auctions. Part 6 discusses the findings in terms of policies for the FCC.

Part 2. Background and Literature Review

The economic studies of discrimination draw on the analyses in Nobel Laureate Gary Becker's *The Economics of Discrimination* (1957). His main contribution was to translate the notion of discrimination into economic terms. His model, when translated

into lending decisions of financial institutions, holds that discrimination will result in either a) higher interest rates being charged to undesired groups having otherwise similar characteristics to the desired group, or b) requiring better characteristics (i.e. a lower expected default rate) for the undesired group at any given interest rate. In other words, firms of the disfavored group might either be appraised more rigorously or, be given less favorable terms on the loan.

Subsequent to Becker's analysis, there has evolved a small but growing number of empirical studies on discrimination against minority- and women-owned businesses in the U.S. capital markets. One problem hindering unambiguous analysis of discrimination has been the availability of the appropriate data. Blanchflower, Levine and Zimmerman (1998), Bostic (1999), Cavalluzzo and Cavalluzzo (1998) and Cavalluzzo, Cavalluzzo and Wolken (2000) used the National Survey on Small Business Finances (NSSBF) to study discrimination against minorities and women in capital markets. Bates (1991) (1997) and Bates and Bradford (1994) use the Characteristics of Business Owners Survey (CBO). Ando (1988) utilizes a special survey. On the whole, these studies indicate that discrimination exists in markets. But the evidence is not complete because of problems with sufficient data. Cavalluzzo, Cavalluzzo and Wolken use data from the 1993 NSSBF to examine the degree to which information on firm and owner characteristics explain observed differences in the capital market experiences of small businesses, with special emphasis on minority businesses. They supplement NSSBF data with information furnished by the Board of Governors of the Federal Reserve on local bank market structure and Dun and Bradstreet firm credit (risk) scores. Their analyses reveal substantial unexplained differences in denial rates between black- and non-minority-

owned firms: the denial rates of black-owned firms were higher. Blanchflower et al also used the 1993 NSSBF data. They found that, after controlling for credit worthiness and other relevant factors, black-owned firms were twice as likely to be denied credit. They also found that black-owned firms pay higher interest rates than non-minority-owned firms after controlling for firm characteristics. Bostic used the 1993 NSSBF data supplemented with detailed demographic and economic data on each firm's local market. He found a statistically significant difference in denial rates between non-minority-owned firms and those owned by blacks, after controlling for firm traits. He also found that the differences between the treatments of black and non-minority businesses could be related to business location, which implies an association between discrimination and redlining. Cavalluzzo and Cavalluzzo used the 1988-89 NSSBF data to examine discrimination against minority businesses in the capital markets. They found that black and Hispanic firms had statistically significantly higher probabilities of loan application rejection than the non-minority firms, after controlling for firm and owner traits. But they concluded that they could not unambiguously show that there was prejudice leading to their results, because of the small sample size, and other data issues. Their conclusion here led to the study above (Cavalluzzo, Cavalluzzo and Wolken).

Bates (1997) used data from the 1987 CBO. The dependent variable in his study was the loan amount, and the independent variables were firm and owner traits that would normally be considered in the lending decision of a financial institution. Bates found that holding other variables constant, financial institutions loaned more per dollar of equity to non-minority firms than to black-owned firms. Bates (1991) used the 1982 (CBO) data and finds the same result: controlling for the impact of other firm and owner

traits, financial institutions loaned more per dollar of equity to non-minority firms than to black-owned firms. Bates and Bradford used a subsample of firms from the 1982 CBO to determine (1) the variables that were statistically significant in predicting survival in 1976-82, and (2) the extent to which the variables from the study were used (along with race) to determine the firms that received venture capital. They found that although race was not statistically significant in determining the failure of firms after controlling for other owner and firm traits, minority firms were less likely to have received venture capital financing than non-minority firms.

Ando's data consisted of self-reported information from business owners that responded to a survey of business owners whose firms were at least two years old in 1984. To examine discrimination in bank lending, she used regression analyses with success in obtaining a loan as the dependent variable, and owner and firm traits as independent variables. Ando concluded that her study found evidence of discrimination against black business owners in obtaining financing.

Although there is a consistency of findings that minorities seeking financing have experienced discrimination in the capital markets, each of the above studies can be criticized in one way or another with regard to data used, model(s) tested, and variables analyzed. In this regard none of the studies is perfect in terms of conclusively proving that discrimination exists. But the preponderance of the findings of discrimination should lead to the hypothesis that discrimination does exist.

In addition, previous studies do not reveal whether minorities or women in particular lines of business experience discrimination. But they do provide the hypothesis that minorities who attempt to acquire broadcast or wireless licenses are hindered in

business by discrimination in capital markets. That is, to the extent that they need funds from the capital markets to obtain licenses or operate their businesses and those funds are differentially restricted to them, the minority businesses will be less successful than their non-minority counterparts. NTIA (1995) does, however, present evidence that minorities in telecommunications encounter discrimination in capital markets, although again, it is inconclusive because the data do not provide sufficient information on the firms in the study. The approach in this analysis is to take the best data available referring to broadcast and wireless firms, and use appropriate statistical tools to determine the evidence of discrimination that exists for minority firms in this line of business.

Part 3. Theory, Data and Statistical Approach

A. A Basic Theory of Lending

Financial institutions make lending decisions based on the business plans and other financial information provided by loan applicants. In this analysis the loan applicant is either a broadcast licensee seeking to acquire a station/license(s) on the secondary market or a broadcast licensee seeking to acquire a license from the FCC. Alternatively, the loan applicant is a wireless entrepreneur that requires debt financing in order to participate in FCC Spectrum Auctions and perhaps purchase associated equipment. In any case, financial institutions evaluate the business plans, the separate components of business plans, and other financial information from potential borrowers.

Suppose that a firm's or an individual's business plan consists of the acquisition of one or more broadcast spectrum licenses or other spectrum licenses and associated facilities. Assume that the firm's primary source of financing the potential license(s) is financial institutions such as commercial banks, investment bankers, finance companies,

etc. The business calculus of the firm is based on the discounted expected earnings before interest, depreciation, and taxes. That is the firm's decision to invest and acquire a broadcast license(s) or other spectrum license(s) is undertaken if the discounted expected cash flow of the licensing opportunity is positive.

Financial institutions that consider the firm's loan application have access to and evaluate the business plan of the firm. The lender evaluates the information in the business plan and forms expectations on the likely success or failure of the proposed license acquisition. Indeed, the expectations of the potential lender may sharply diverge from the expectations of the entrepreneur, which are embedded in the business plan. In addition, financial institutions are also likely to consider the experience of the firm's management and the human capital of top management. The institutions will examine the credit worthiness of the firm, the size of the firm, the years that the firm has been in the broadcast business, the overall cash flow of the firm, and the growth of the firm. The evaluation of these variables is the basis of the expectations of the lender on the likely success of the proposed broadcast license. We assume that the lender approves the loan if the lender's discounted expected cash flow from the potential borrower is positive. That is, if

$$(1) \quad -C_0 + \sum_{t=1}^T E \frac{g_t(\text{Cashflo}_t, CW_t, \dots)}{(1+r)^t} > 0.$$

The amount of the loan is C_0 . The function $g_t(\cdot)$ maps the firm's cash flow into the lender's cash flow. The discount rate is r , and E is the expectation operator. The variable Cashflo_t , $t = 1, \dots, T$, is the random variable for the firm's cash flow which includes the incremental cash flow of the wireless project. The variable CW_t , $t = 1, \dots, T$, is the

random variable for creditworthiness. Time is indexed by t , and $g_t()$ is composed of other random variables presented by the borrower's application, e.g., random variables on the equity of the firm over time and debt- to-asset ratios of the firm over time. We specify the equation for the probability of debt approval for most recent license acquisitions of borrowers that are current license holders.

B. Description of the Data

For broadcasting, the data are from a survey of current broadcast license holders. The FCC contracted the survey for the fall of 1999. The survey instrument was mailed to a random sample of non-minority license holders. In addition, a census was taken of minority license holders.² The data consist of firm characteristics. Data are also available on the financial condition of the firm at the time of its most recent license acquisition. That is, excluding the specific acquisition, the data provide a financial portrait of the firm before and during the actual acquisition of its most recent license. Data are also available on the firm's characteristics during the year of the most recent acquisition. For the most recent acquisition, information on the number of attempts required to obtain debt financing from financial institutions is contained in the data. The survey instrument also provided data on the interest paid on the debt that financed a broadcaster's most recent license acquisition. There are 99 current license holders in the data, however there is item non-response on variables that may have been useful in understanding approval/denial decisions.³ It is noted that the data only covers broadcasters who obtained licenses through the comparative hearings process or on the secondary market—no broadcast auctions were included.

² The response rate for the survey was 30 percent.

For attempts to acquire wireless licenses, financial data and other data on auction applicants are from the FCC Auction Application Survey. Auction applicants were asked to discuss their latest license acquisition or attempted acquisition. In addition, information was gathered on how the license applicants had financed the acquisition and the financial measures describing their financial condition at that time. In the Auction survey, the number of eligible respondents was 1,515. There were 251 responses and 38 refusals, for an overall response rate of 19%. The Auction Survey data are supplemented by data from the FCC Website. Data on both the number of qualified bidders and the number of applicants are taken from the FCC Website.

C. Statistical Approach

In order to determine if the results of the analyses below are sufficiently robust for purpose of generalization, the meaning of how the results are described should be clarified. The statistical tests below compare the effect of race (e.g. minority) on the dependent variable (e.g. the probability of a loan application acceptance) after considering the impact of other independent variables on the probability of the application being accepted. These other independent variables include the firm's cash flow, equity, and other business traits that would normally be considered in the lending decision of a financial institution. The standard format is followed in this study, which is

³ The FCC also attempted to survey broadcast applicants, but the data on addresses were too old and thus contained many errors. Thus the information provided was not sufficiently useful.

to test the hypothesis that the independent variable such as race, has no effect on the dependent variable, when the effects of the other independent variables are considered. A conclusion that race or gender is “statistically significant” in a regression means that the hypothesis of no effect is rejected because the probability of finding those results if race (or gender) has no effect is 10% or less. Although 10% is the cutoff used in this study, many of the results hold at less than 1%, and some less than 0.1%.

The regression results may not be conclusive because the results may omit other confounding variables. In its data collection efforts, the FCC attempted to collect all relevant data that would explain debt and equity financing in capital markets. The data collection was characterized by low response rates and item non-response. Additional efforts to collect market and firm characteristics may be characterized by the same problems of non-minority non-response and item non-response.

Part 4. Obtaining Debt Financing in Capital Markets

This section focuses on the lending decisions of financial institutions. For the most recent acquisition or attempted acquisition of both broadcast licensees and wireless auction applicants, the lending decisions of financial institutions are examined in order to determine whether minority or female status reduced the likelihood of approval on loans. This section also examines whether minority- and women-owned firms pay higher interest rates when they obtain loans from financial institutions.

A. Descriptive Statistics on Broadcast Firms and Auction Participants

Before presenting the statistical analyses, it will be informative to examine relevant statistics that describe the capital market experience of the firms in the study. Exhibit 1 shows that 58% of the successful broadcast firms and 43% of the auction

participants applied for debt financing in the capital markets. These percentages may be understated since some firms may have inquired but not applied because they were discouraged. These data show that there is significant dependence on capital markets by broadcast firms and by auction participants.

Exhibit 1

Summary Statistics for Broadcast Firms and Auction Participants

		Successful Broadcast Applicants ¹ (N=235)		Auction Participants (N=251)	
Minority-Owned ²	Minority	37	15.7%	36	14.3%
	Non-Minority	121	51.5%	235	85.7%
	Missing	77	32.8%		
Woman-Owned	Woman	20	8.5%	37	14.7%
	Not Woman	138	58.7%	234	85.3%
	Missing	77	32.8%		
Sought Financing Other than Own Equity ³	Sought Financing	136	57.9%	108	43.0%
	Did not seek financing	88	37.4%	143	57.0%
	Missing	11	4.7%		
Obtained Debt Funding ⁴	Obtained	125	53.2%	86	34.3%
	Did not obtain	10	4.3%	165	65.7%
	Missing	100	42.6%		

Notes to Exhibit 1:

1. Successful applicants are those that acquired at least one license in their latest attempt to acquire a license.
2. If the respondent did not explicitly indicate minority-owned business, the business was coded as non-minority.
3. If the respondent indicated that the firm had sought financing or that it had received financing, then coded as having sought financing.
4. If the respondent sought financing and indicated loan amounts, terms or conditions the loan was coded as approved.

A. Estimation: Approval/Denial for Debt Financing: Broadcast Licensees

The Broadcast Survey Instrument requests information on the number of attempts made to obtain debt financing from sources other than family/friends. Another question requests information on the number of denials of attempts to obtain debt financing from

sources other than family/friends.⁴ For any respondent that answered these questions, the loan application denial rate is the ratio of denials to attempts, and the approval rate is one minus the rate of denial.

A binary dependent variable may be created by assuming that a loan is approved whenever attempts exceed denials: Loan Approval = "Yes" if Attempts > Denials (i.e., the applicant received a loan) or Loan Approval = "No" if Attempt = Denials (the applicant did not receive a loan). However, this approach does not consider information that is critical to understanding discrimination in capital markets. For example, suppose that a minority firm has 10 attempts and 8 denials, and a majority firm has 2 attempts and 1 denial. The binary dependent variable for both firms would be Loan Approval = "Yes". However, the average probability of approval for the minority firm is 20%, and the average probability of approval for the majority firm is 50%. Use of a binary dependent variable would ignore this information. To the extent that filing a loan application requires both direct and indirect costs, the expenses associated with search, out-of pocket, and managerial time may be a manifestation of capital market discrimination. Therefore, a modified logistic model is used to estimate the average probability of approval. The modified log odds is used in order to fully utilize all the information on attempts and denials in capital markets.⁵

The probability of approval is an implicit function, $g(\text{Independent Variables})$, of observed values. Thus here the independent variables are those variables equal to or highly associated with those in expression (1) that affect the probability of loan acceptance (cash flow, etc.). Because the exact form of the function $g(\)$ is unknown,

⁴ Both questions provide financial information about a company based on the most recent application for or secondary market acquisition of a license(s).

seven models are estimated . The models of Table 1 utilize available data and variables that are informed by our theory of behavior in debt markets. The variables in the models include the following:

Cash flow: The respondent's cash flow prior to the most recent auction. Equal to net income plus depreciation and amortization plus deferred taxes.

Interaction between Race and Cash Flow: The product of Race and Cash Flow.

Cash flow Squared: Cash flow squared.

Equity: Assets minus total debt.

Equity Squared: Equity squared.

Interaction between Race and Equity: The product of Race and Equity.

Full Time Employees (FTE): The number of full-time employees.

FTE Squared: The number of full-time employees squared.

Gender: One if the respondent identified the company as women-owned, and zero otherwise.

Race: One if the respondent identified the company as minority-owned, and zero otherwise.

The period of license applications or attempted acquisition by current broadcast licensees spans 1970 through 1999. Over the course of these twenty-nine years, conditions in capital markets have varied significantly. Therefore, the models in Table 1 include controls for the year of the license application or attempted acquisition. In addition, the models in Table 1 consider interactions between race and other explanatory variables in order to determine whether race is used as a possible discriminatory filter when financial institutions evaluate applications and associated business plans. Finally,

⁵The modified log odds can be found in Wonnacott and Wonnacott (1979), Chapter 4.

nonlinear relationships are included in the models in Table 1 through the cash flow squared and equity squared.

The models are analyzed by the use of ordinary least squares estimation using SAS software. The results of the analyses support the hypothesis that race matters and that race is a determining variable in the approval/denial of a loan application of current broadcast licensee.

In Model 1, the control variables are cash flow, equity, and size of the firm as measured by the number of full time employees, gender and race. In Model 1, the coefficient of the variable that controls for minority ownership is negative and statistically significant. This result implies that a minority-owned broadcast licensee is less likely to obtain a loan approval from financial institutions than a nonminority broadcast licensee. Model 2 reduces the number of time groups, but adds the nonlinearity in the size of the firm into the specification. The result is that, after controlling for relevant variables, the coefficient of the variable reflecting minority ownership is negative and statistically significant. The results of this model also indicate that the loan application of a minority-owned broadcast licensee is less likely to be accepted by financial institutions. In both Model 1 and Model 2 the variable that controls for female ownership is included in the specification. For both models, a female-owned broadcast licensee has a lower probability of debt approval than a male-owned firm, but these results are not statistically significant. Model 3 eliminates consideration of gender and has the same adjustment for different time periods as Model 2. The results of Model 3 also conclude that a minority-owned broadcast licensee has a lower probability of a loan approval from financial institutions than nonminority firms. This follows from the

results that in Model 3, the coefficient reflecting minority ownership is negative and statistically significant.

B. Interest Rates Paid by Broadcast Licensees

The survey provides data on the interest paid by borrowers on loans from financial institutions. Table 2 contains two models of interest rates charged by financial institutions on loans to broadcast licensees on their most recent acquisitions. Both models in Table 2 include dummy variables for the period that the application/acquisition occurred.⁶ Our theory suggests that the decision to approve a loan is a simultaneous decision on the interest rate and other terms of the loan. Therefore, explanatory variables of the debt approval models of Table 1 are used to form the Models of Table 2. The models of Table 2 are estimated with the ordinary least squares procedures of the SAS Software.

The results in Table 2 indicate that race affects interest rates that are charged to minority licensees in their most recent acquisitions. Specifically, minority-owned firms pay higher interest rates when we control for the other variables in the models. Just as in the models of loan approval, the lender's analysis of various components of the application and associated business plan affects the lender's decision on the interest rate that is charged the borrower. This effect is shown in Model 1 of Table 2. The coefficient for the interaction between race and the firm's debt-to-asset ratio is positive and significant. This means that when a non-minority firm and a minority firm present the same debt-to-assets ratio to a financial institution, the minority firm is charged a statistically significant higher interest rate by the financial institution. The decision to

⁶The default year is 1972.

lend is a simultaneous decision to lend an amount, at an interest rate, for a term, with conditions. Thus we also add the condition of collateral and personal guarantees as explanatory variables of the interest. These variables are defined as follows:

Indicator variable for personal guarantee: One if the respondent was required to make a personal guarantee, and zero otherwise.

Indicator variable for collateral required: One if the respondent indicated that collateral was required on the debt, and zero otherwise.

Because of item non-response on questions addressing collateral and personal guarantees, 10 observations are deleted because of missing data. In addition, we include two non-linear measures in the specification of Model 2: FTE squared and Cash flow squared. The results of Model 2 are that collateral and personal guarantees affect the interest rate paid by the borrower. Model 2 also indicates that race does matter in the lender's decision on interest rates. The coefficient of the interaction between race and the equity of the firm is positive and statistically significant: minorities pay higher interest rates relative to amount of equity, when we control for the impact of the other variables. This indicates that a minority firm with the same equity as a nonminority firm is charged a higher interest rate than the nonminority firm, controlling for the other variables in the model. In addition, the coefficient of the interaction between race and the debt-to-assets ratio is positive and statistically significant as in Model 1. This adverse reaction of lenders to the minority firm's equity and debt-to-assets ratio is somewhat moderated by the negative sign of the interaction between race and cash flow. That is, lenders reduce the interest rates on loans to minorities in reaction to cash flows more than they reduce the interest rate charged to nonminority firms. The interest rates paid by women-owned businesses were also examined in regression models. It was found that any differences in the

interest rates paid by women-owned businesses were not statistically significant. The models were hampered by small sample sizes, and will not be reported. The impact of gender on the interest rates of auction participants is similar to that of broadcast licensees and those results will be reported below.

C. Approval/Denial of Debt: Auction Applicants

The models of financial institutions' decisions on loan applications of auction applicants are analogous to the models of financial institutions' decisions on loan applications of broadcast licensees. The dependent variable of this regression is the average probability of the financial institution approving the loan application. The dependent variable is one minus the average denial rate, where the average denial rate is constructed from the reported number of loan applications a respondent submitted to financial institutions and the number of loan denials the respondent reported in the Auction Survey. The data include applicants that were unsuccessful in obtaining debt financing.

Again, a modified logistic model is specified and then estimated with ordinary least squares using SAS software. The modified log odds is used in order to fully utilize all the information on attempts and denials in capital markets. Since the Auction Survey spans the years from 1994 into 1999, dummy variables control for the year of an applicant's most recent auction. Other variables in the specifications are listed below:

Number of licenses won before last auction: The reported number of licenses won prior to the respondent's most recent auction.

Number of licenses won before last auction squared: The square of the number of licenses won before the last auction.

Cash flow: The respondent's cash flow prior to the most recent auction.

Cash flow Squared: Cash flow squared.

Equity: Assets minus total debt.

Equity Squared: Equity squared.

Indicator variables for auction groups: The dummy variable Auction Group Other Wireless Spectrum takes the value of one when the applicant's participated in Auctions 1, 2, 3, 14, or 21, and zero otherwise. A dummy variable called Mobile Voice and Data Wireless Spectrum takes the value of one when the applicants most recent auction was Auction 4, 5, 7, 10, 11, 12, 16, 18, 20, 22, or 24, and zero otherwise. The grouping of auctions is based upon potential economic spectrum usage and technology as indicated by the Office of Engineering and Technology.

Indicator variable for a Start-up: One if the company was a startup at auction time, and zero otherwise.

Gender: One when the respondent identified the company as women-owned, and zero otherwise.

Race: One whenever a respondent identified the company as minority-owned, and zero otherwise.

Full Time Employees: The number of full time employees.

Interaction between Race and Cash Flow: The product of Race and Cash Flow.

Interaction between Gender and Cash Flow: The product of Gender and Cash Flow.

Interaction between Startup Status and Cash Flow: The product of Startup Status and Cash Flow.

Interaction between Race and Equity: The product of Race and Equity.

Interaction between Gender and Equity: The product of Gender and Equity.

Interaction between Startup Status and Equity: The product of Startup and Equity.

Table 3 contains models of the approval decisions of financial institutions on the loan applications of auction applicants. The results of the three models of Table 3 suggest that race and gender matter in the approval of debt for auction applicants. This result follows because the regression coefficients associated with race and gender are negative

and statistically significant. After controlling for the time of the most recent auction, the size of the firm, the equity of the firm, the cash flow of the firm and other relevant variables, a minority-owned firm's loan application had a lower probability of acceptance than that of a non-minority firm. In addition, the coefficient associated with a woman-owned firm is negative and statistically significant. This implies that a woman-owned firm was less likely to be approved for debt by financial institutions. The direction of some of the interaction variables may, however, moderate these results.

D. Interest Rates on the Debt of Auction Applicants

This section investigates whether minority- or woman-owned auction applicants are charged higher interest rates by financial institutions after controlling for relevant variables. Since a loan approval is associated with a specific interest rate, many of the variables influencing a loan approval should influence the interest rate that the financial institution selects to charge the spectrum applicant. Additional variables are incorporated in the analysis of interest rates. The additional variables are listed below:

Personal guarantee: One if the respondent was required to make a personal guarantee, and zero otherwise.

Collateral required: One if the respondent indicated that collateral was required on the debt, and zero otherwise.

The responses of auction applicants on interest rates were characterized by high item nonresponse. Thus in order to include as many cases as possible, the interest rate model includes firms that obtained loans from family/friends. That is, a dummy variable is created to control for the effect of family/friends lending activities. The variable **Family** is one if the lender is family/friend, and zero otherwise.

Table 4 contains three models of the interest rate charged to auction applicants. The regression coefficient associated with a minority-owned firm is positive and statistically significant. Thus, after controlling for time, whether collateral was required, whether a personal guarantee was required, the size of the applicant, equity, cash flow, and other relevant variables the data support the hypothesis that minority-owned firms were charged higher interest rates than nonminority firms. This result is, however, somewhat moderated by the effect of a lender's expectation of a minority-owned firm's positive cash flow. Gender was not found to be statistically significant in the models.

In summary, race and gender matter in a lender's approval of a loan application. Moreover, race matters in a lender's decision on interest rates charged to borrowers. The data suggest that lenders can and do evaluate components of applications and associated business plans of minority-owned firms and women-owned firms differently from those of non-minority firms. That is, when a specific and identical characteristic of a minority firm and a non-minority firm is presented to a lender, the lender differentially evaluates the characteristic. The result of this process is that among current broadcast licensees, minority status has a statistically significant negative impact on the approval of loans in their most recent application. Also, minority status increases the interest rates that the borrowers pay. This result is also statistically significant. Female gender also has a statistically significant negative impact on loan acceptance. However, female gender was not found to have a differential impact on the interest rate on loans granted by lenders. These relationships are also true for spectrum applicants.

Part 5. The Probability of Winning in Auctions

A preliminary examination of the rate at which minorities and women successfully obtained licenses in auctions for wireless licenses, compared to the rate at which minorities and women applied to participate in FCC auctions, suggests that minorities and women may have been underrepresented in obtaining FCC licenses through auctions. Such “utilization calculations” suggest the need for further evaluation, using more sophisticated economic calculations and controlling for other relevant variables. Are the differences in average utilization due to race or other factors? Given evidence of capital market discrimination in applicants’ financing of their most recent auction acquisition, the hypothesis of whether minority or women applicants have lower probabilities of winning a spectrum license is investigated. The analysis of the probability of winning a spectrum licenses is informed by auction theory and multiple data sources. The empirical results are based on both survey data and FCC auction data. The data supports the hypotheses that both minorities and women have lower probabilities of winning spectrum licenses in auctions after controlling for relevant variables. These results, however, are not conclusive due to the lack of comprehensive data. The information from the survey is characterized by a high non-response rate and high rates of item nonresponse.

A. Auction Behavior

In order to model auction outcomes we outline the economic behavior of auction applicants. It is assumed that individuals/firms participate in auctions because they ultimately expect to make a profit from the control of a spectrum license(s). An auction participant calculates its private valuation of spectrum licenses in a given auction. In

doing so the participant calculates the discounted expected value of its wireless project, where the project may or may not include the building of facilities. In any event, the bidder is likely to consider expected demand and costs for any planned wireless services in targeted markets. The demand and cost data would ultimately depend on population and income of the targeted market areas. In addition, the business plan of the spectrum applicant would consider the number of competitors for the particular spectrum and associated services.

The probability of applicant i winning a license, $P(V, C_i)$, is a function of the valuation placed on a license, denoted V , and the amount of funds available to bid, C_i . The amount that a participant can bid is the minimum of the value placed on the license or the amount of funds available to bid. This analysis considers that C_i is a function of the capital markets. That is, if there is no capital market discrimination, $C_i = f(Z_i)$ where $f(Z_i)$ is the amount of financing made available to a non-minority firm given the firm and owner traits Z_i . The function $G(\cdot)$ is defined such that $0 \leq G[f(Z_i)] < f(Z_i)$ when capital markets exhibit bias against minority- and/or women-owned firms. If $G[f(Z_i)] < f(Z_i)$ but $V < G[f(Z)]$ for minority- and/or women-owned applicants, then minority and/or women applicants are not limited by capital market constraints, and they fully participate. However, if $G[f(Z_i)] < f(Z_i)$ but V is distributed so that $V > G[f(Z)]$ for minority- and/or women-owned applicants two outcomes will happen. First, the auctions won by minorities and women will be skewed toward low price auctions. Second, the overall proportion of auctions won by minorities and women will be less than if no capital market constraints existed, or alternatively, less than if auctions were distributed among the applicants by Z_i . The statistical models below consider that when

minorities or women are constrained in obtaining financing from capital markets, $G[f(Z_i)] < f(Z_i)$ for minorities and/or women, and they are constrained in their ability to bid.

The unique features of an auction along with the array of maximum bidders determine the actual outcome of the auction. The statistical models used below consider the characteristics of the auctions and firm traits (elements of Z_i), along with race and gender of the firm's owner. We test to determine if race and gender are statistically significant in predicting success, controlling for the other variables in the models. We do not have information on the amount of financing available for each participant. But when controlling for auction features and firm traits, if minority status or female-owned status results in a lower probability of winning an auction, our interpretation is that minority status or female status, per se, does not affect a participant's ability to bid; but the *capital constraints* associated with minority status or female status (i.e., $G[f(Z_i)] < f(Z_i)$) reduces the ability of the minority- or woman-owned firm to win in an auction.

B. Description of the Data

The data for the analysis are from the FCC Auction Survey (see above). On the Auction Survey the respondent is asked to provide the number of licenses won in its most recent auction. The most recent acquisition occurred in 1999. The response to the number of licenses won in its most recent auction is the dependent variable. The dependent variable is binary, equal to one if the applicant won spectrum licenses in its most recent auction, and zero otherwise. The explanatory variables are listed and described below.

Indicator variables for time: Dummy variables are used to control for the year of the most recent auction that applicants participated.

Auction groups: Auction Group Other Wireless Spectrum takes the value of one when the applicant's participated in Auctions 1, 2, 3, 14, or 21, and zero otherwise. Mobile Voice and Data Wireless Spectrum takes the value of one when the applicant's most recent auction was Auction 4, 5, 7, 10, 11, 12, 16, 18, 20, 22, or 24, and zero otherwise. Grouping of auctions is based upon potential economic spectrum usage and technology as indicated by the Office of Engineering and Technology.

Start-up: One if the company was a startup at auction time, and zero otherwise.

Bidding credit: One if the respondent indicated having participated in a bidding credit program, and zero otherwise.

Installment Plan: One if the respondent indicated having participated in an installment program, and zero otherwise.

Upfront Payment: The amount of upfront payment in the most recent auction of a respondent.

Gender: One if the respondent identified the company as women-owned, and zero otherwise.

Race: One if the respondent identified the company as minority-owned, and zero otherwise.

Full Time Employees: The number of full time employees.

Number of Competing Applicants: The total number of applicants in the most recent auction of the respondent.

Number of Qualified Bidders: The total number of qualified bidders in the most recent auction of the respondent

Availability of Minority Bidding Credit: One if the minority bidding credit was available in the most recent auction of the respondent, and zero otherwise.

Debt-to-Asset Ratio ("D/A"): Total debt divided by total assets.

Interaction between Race and D/A: The product of Race and D/A.

Interaction between Gender and D/A: The product of Gender and D/A.

C. Estimation Results: Probability of Winning

Table 5 contains the result of the econometric analysis of the probability of an applicant winning a spectrum license. The results are derived from a logistic/probit regression using SAS. The data supports the hypothesis that minority status results in a lower probability of winning spectrum. That is, for the respondents of this sample, the probability of a minority winning a spectrum license in his/her most recent auction is lower than the probability of a nonminority firm/entity winning a spectrum license in its most recent auction. For each of the seven models, which control for time, auction group, startup status, size of company, financial strength, and competition, minority status results in a lower probability of winning. In five of the seven models tested, female gender was statistically significant in predicting a lower probability of success in spectrum auctions. In the other two models female gender was found to reduce the probability of success, but the results were not statistically significant. Finally, the results in Table 5 show that each of the seven models is statistically significant in specifying success of the participants.

Part 6. Discussion of the Findings and Recommendations

In Adarand Constructors, Inc. v. Pena, 515 U.S. 200 (1995), the United States Supreme Court determined that federal programs that use race or ethnicity as a basis for decision-making are subject to strict judicial scrutiny. Thus, any such programs must serve a compelling governmental interest, and must be narrowly tailored to serve that interest. The Supreme Court has recognized that remedying past discrimination constitutes a compelling government interest. See Adarand, 515 U.S. at 237; City of Richmond v. J.A. Croson Co., 488 U.S. 469, 509 (1989) (plurality opinion); id. At 511

(Stevens, J., concurring in part and concurring in the judgment). To prove such a remedial government interest, evidence of discrimination, which may include statistical analyses, is required. This analysis of broadcast license holders and wireless applicants suggests that minorities and women experience discrimination in capital markets. Moreover, that discrimination adversely affected their most recent acquisitions of broadcast licenses and wireless licenses. It is suggested that a national policy of auctioning spectrum, without remedying discrimination in capital markets, is a national policy of discrimination against minorities and women in the allocation of spectrum licenses. This is because the auctions of the FCC require up-front payments and because spectrum licenses go to the highest bidder. When there is capital market discrimination, minorities will be capital constrained and less likely to qualify for any auction and less likely to win auctions. The data presented suggest that minorities are less like to win wireless licenses after controlling for relevant variables.

The regression results may not be conclusive because the results may omit other confounding variables. In its data collection efforts, the FCC attempted to collect all relevant data that would explain debt and equity financing in capital markets. The data collection was characterized by low response rates and item non-response. Nevertheless, the results of this study are consistent with and reflect the long history and contemporary problems of race in the culture, economy, politics, and jurisprudence of the United States.

The recommendations that result from this study are as follows. First, it is recommended that the FCC develop and maintain programs that seek and encourage the participation of minorities and women in the ownership of broadcast and spectrum licenses. Such efforts may offset the disadvantages that minority- and women-owned

firms experience through the capital markets. Second, it is recommended that the FCC continue to examine the effect of capital markets on the participation of minority- and women-owned firms in the ownership and operation of broadcast and spectrum licenses. Although this study indicates that minority- and women-owned firms are inappropriately disadvantaged in this line of business due to capital market forces, more research is needed to confirm and track these effects over time.